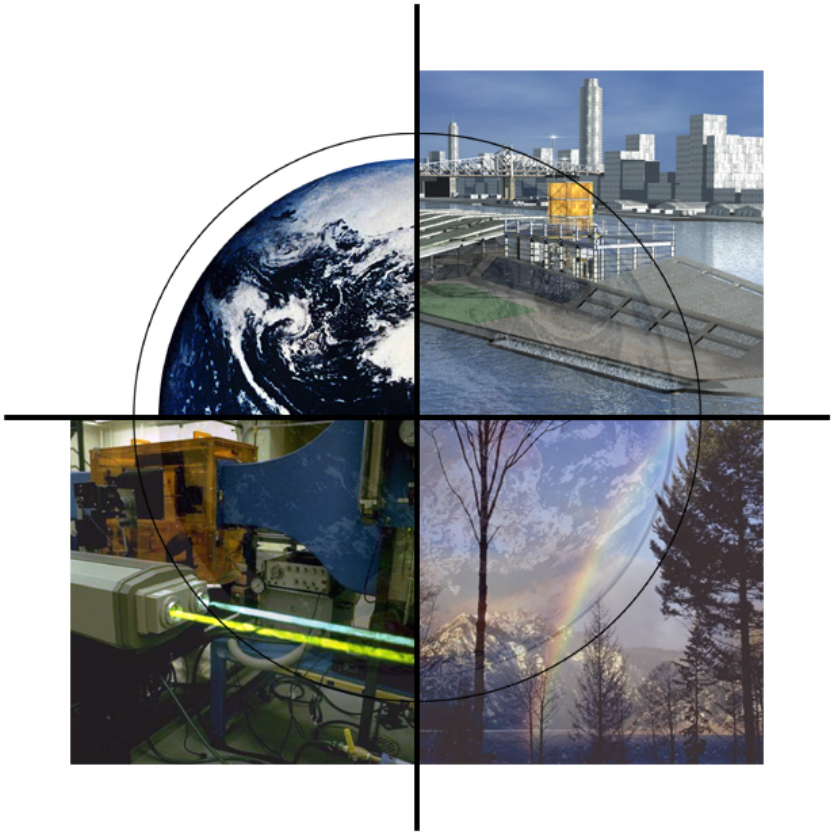
DOE Office of Fossil Energy
Carbon Sequestration Program



Fifth Annual Conference on Carbon Sequestration

May 8-11, 2006

Sean I. Plasynski, PhD

Sequestration Technology Manager

National Energy Technology Laboratory

NETL

Office of Fossil Energy

Outline for Presentation

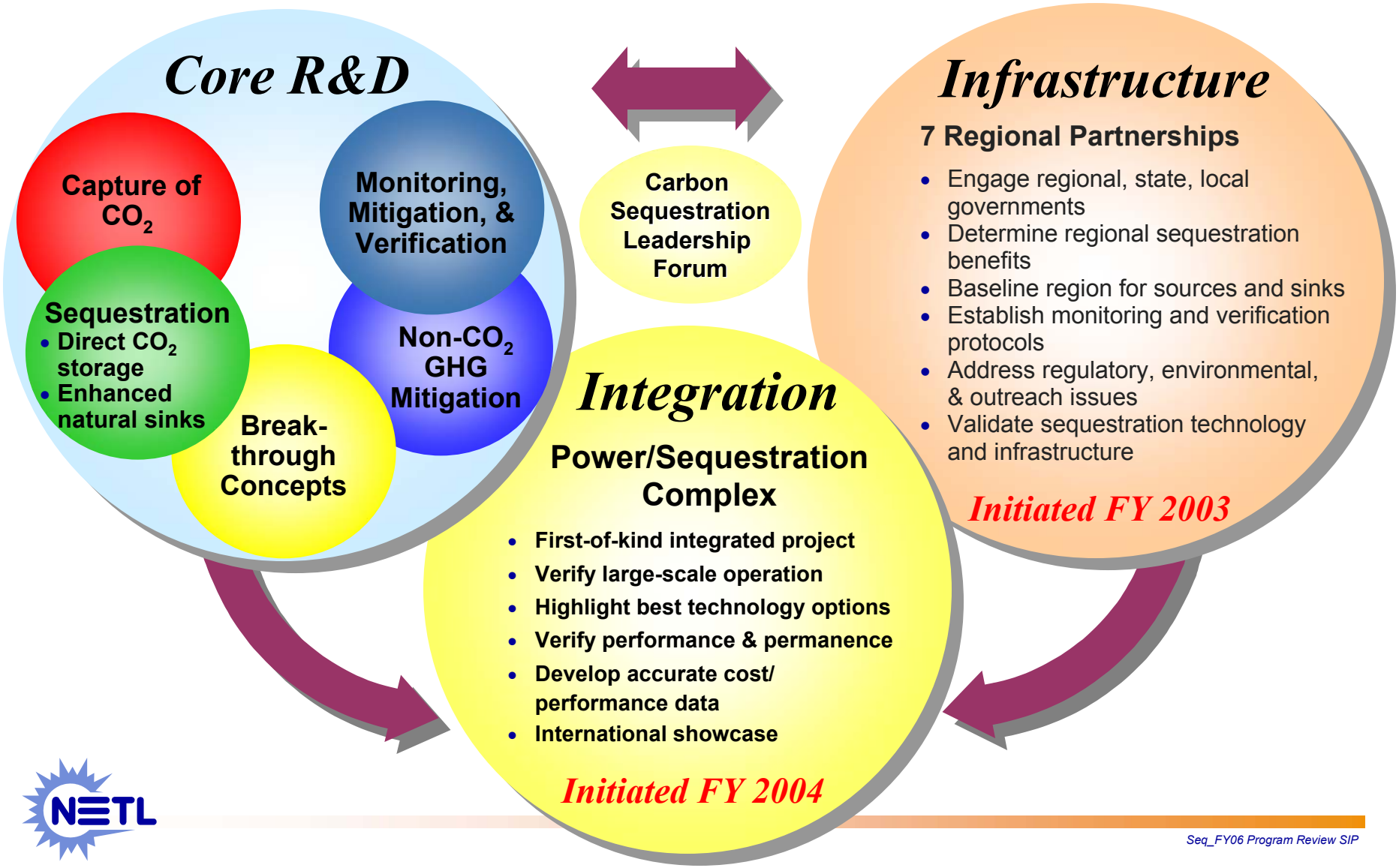
High-Level View

- many previous talks gave details

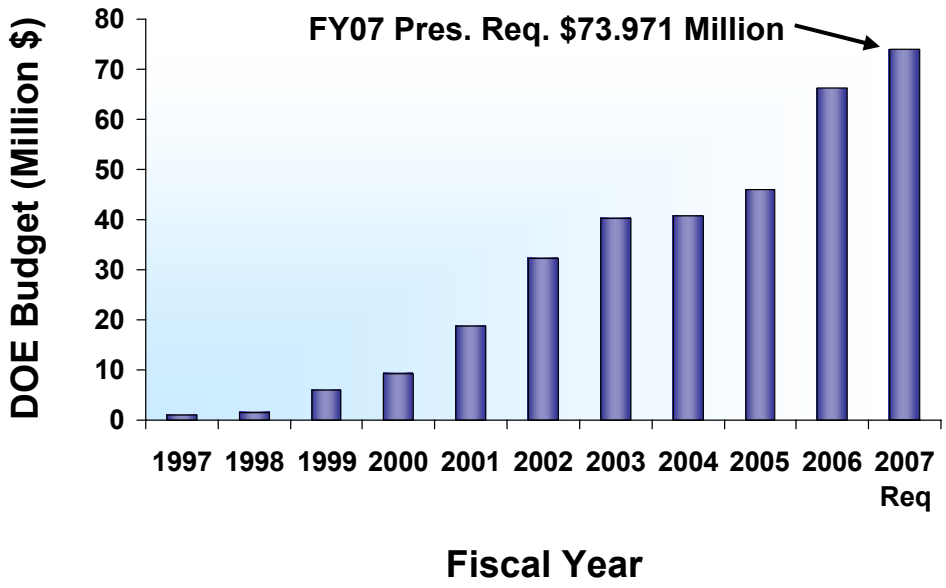
- **Program Structure**
- **Portfolio Overview**
- **Program Goals**
- **Programmatic Highlights**
- **Future Opportunities**

GOAL – Brief and to the Point ! It's Lunchtime!

Carbon Sequestration Program Structure



Sequestration Program Statistics FY2006



Strong industry support

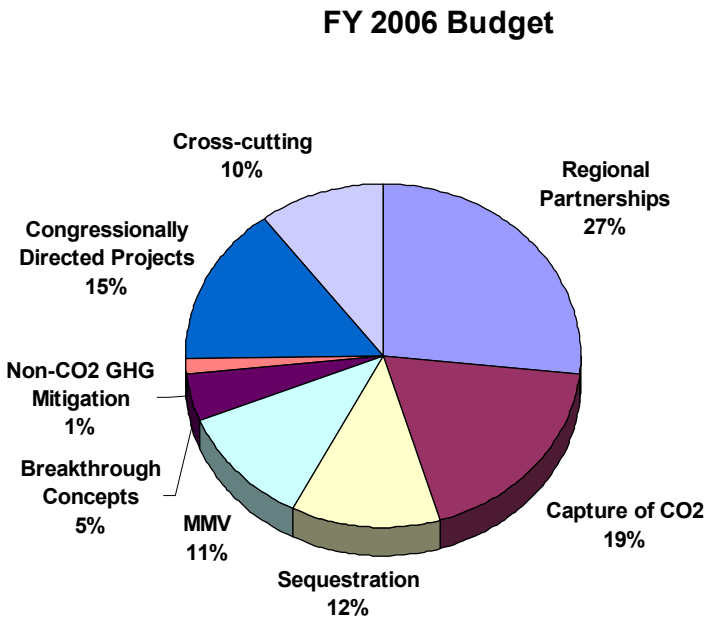
~ 39% cost share on projects

Federal Investment to Date

~ $260 Million

Diverse research portfolio

~ 70 R&D Projects



Sequestration Program Goals

Develop Technology Options for GHG Management That...

- Are safe and environmentally acceptable
- Separation and Capture R&D Goals
  - 2007 have two technologies < 20% increase in Cost of Energy ***
  - 2012 developed two technologies < 10% increase Cost of Energy
- Sequestration/Storage R&D Goals
  - 2012 predict CO_2 storage capacity with +/- 30% accuracy
  - Develop best practice reservoir management strategies that maximize CO_2 trapping
- Monitoring, Mitigation & Verification
  - 2012 ability to verify 95% of stored CO_2 for credits (1605b)
  - CO_2 material balance to >99%

Cost Performance Goals

Year	COE Penalty IGCC Plants (% Increase)	COE Penalty PC Plants (% Increase)
2002	30	80
2007	20	45
2012	10	20
2015	<10	10
2018*	0	0

*Cost/Energy offset from sequestering CO_2 with criteria pollutants NOX, SOx, H2S (gasification)

*** technologies identified and ready to move to demonstration (~ 4yrs) and then deployment (~4 yrs) – IGCC 20% and PC 45%

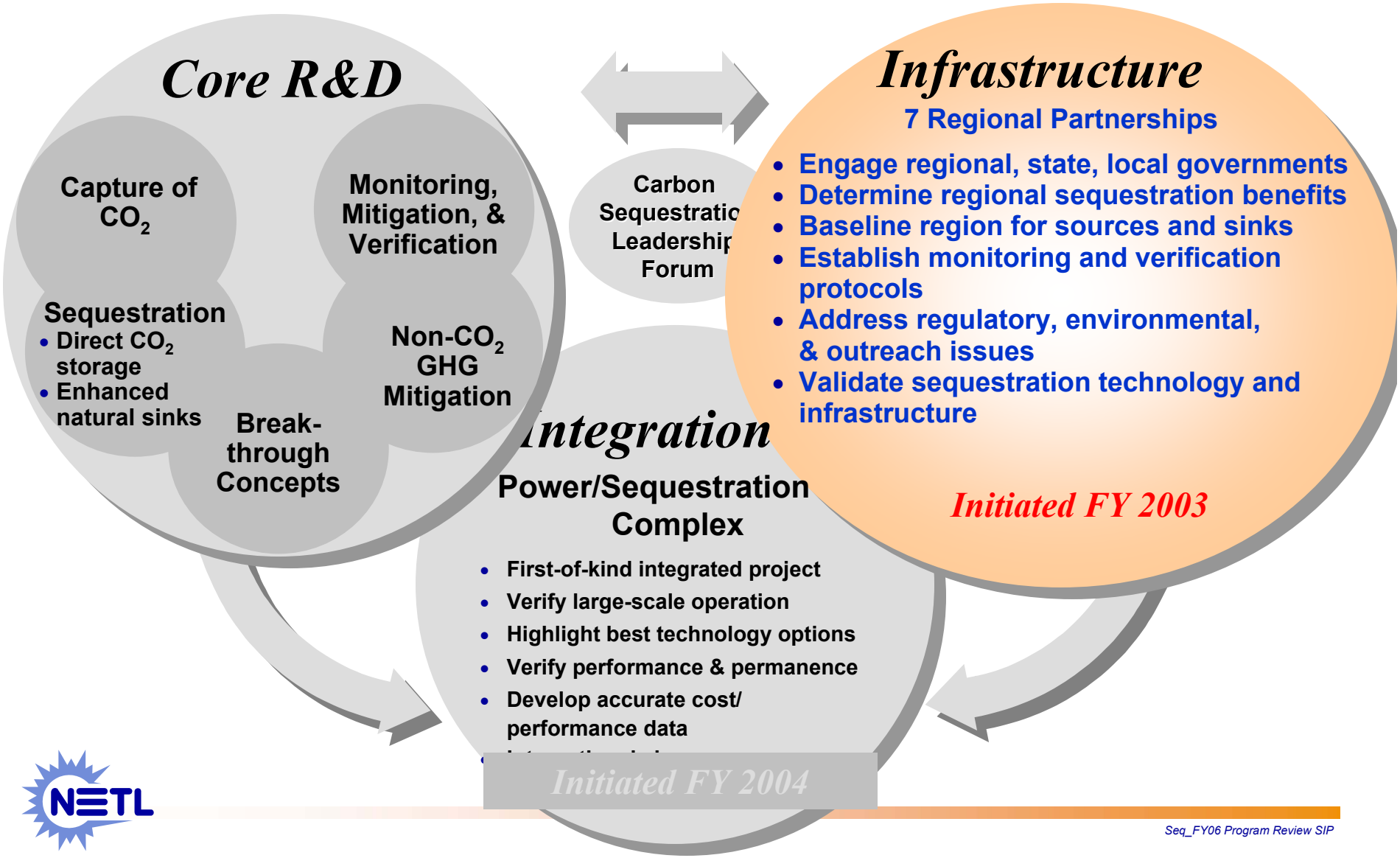
2006 Programmatic Highlights

- 2006 Sequestration Roadmap and Project Portfolio Available
- Regional Partnerships Phase II – Field Validation Testing Projects Initiated
- Regional Partnerships Designated as a CSLF Project
- OxyCombustion and Other CO_2 Capture Technologies Solicitation (DE-PS26-05NT42464) Selections
- Novel Technology and Commercially Focused Approaches to CO_2 Capture and Separation… (DE-PS26-06NT42829) Solicitation Released
- ASME Review of Projects
- NRC/NAS Review of Program
- Discussions and Engagement with EPA concerning Regulations for Sequestration
- Discussions with Office of Science on Collaboration

2006 Outreach Efforts

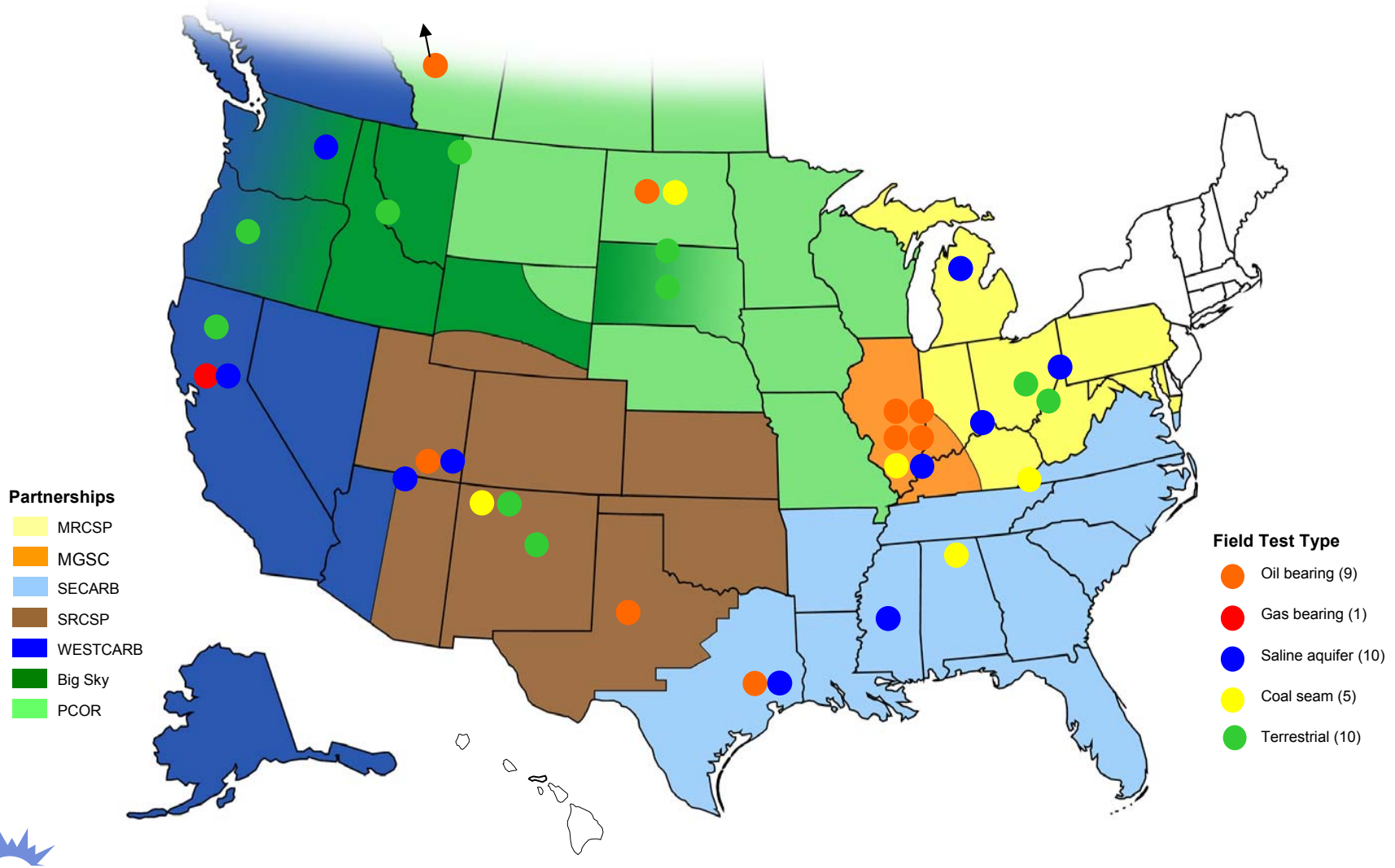
- **Educational Outreach Curriculum**
  - Middle School and High School curriculums complete
  - Disseminated through workshops at the National Science Teacher Association Conference in April and October 2006
- **Development of Programmatic Outreach Materials**
  - Carbon Sequestration FY2006 Technology Roadmap
  - Carbon Sequestration Monthly Newsletter
- **Carbon Offsets Opportunity Program**
  - Web-based system that matches potential investors with greenhouse gas offset and reduction projects
  - Site will be maintained and enhanced this year based on stakeholder feedback
- **Stakeholder Meetings**
  - Regional Partnerships

Carbon Sequestration Program Structure



Regional Carbon Sequestration Partnerships

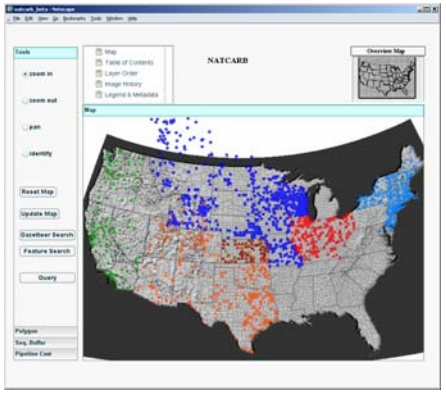
Validation Phase Field Tests



Regional Partnership Update
"Developing the Infrastructure for Wide Scale Deployment"

Phase I (Characterization)

- 7 Partnerships (40 states)
- 24 months (2003-2005)



Phase II (Field Validation)

- 4 years (2005 - 2009)
- All seven Phase I partnerships continued
- $100 million federal funds
- $45 million in cost share

Phase III (Deployment)

- 8 years (2009-2017)
- Large Scale Injection Tests

Separation & Capture R&D

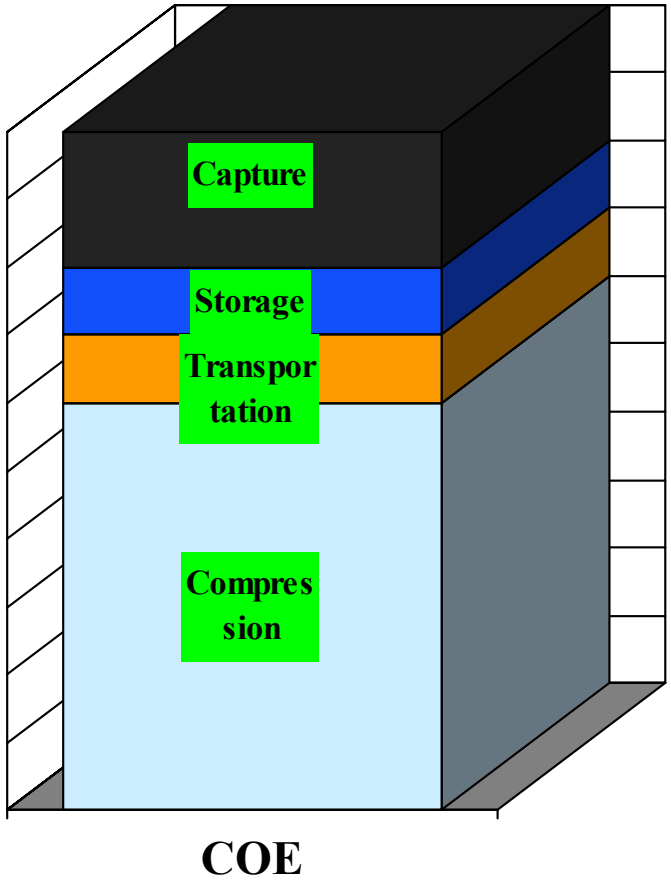
Why Capture Costs Important

Issue

- Demonstrated technology is costly
- Scale-up (Lab scale to Commercial Plant)

Pathways

- Pre-combustion capture
- Post-combustion capture
- Oxygen-fired combustion
- Optimized engineering



d to Focus on the rogram Objectives

Strain on infrastructure – rail lines, growth unseen for decades – workforce issues.

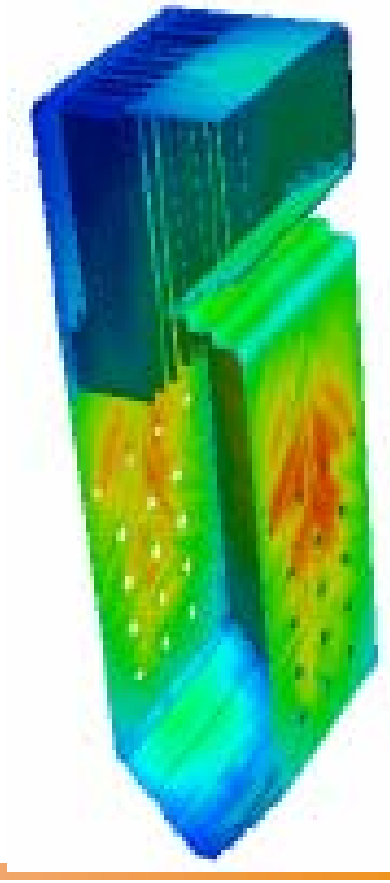
Energy Penalty due pture	10%	20%	30%	40%
Target Market, GW (<30yrs MW)	184	184	184	184
Fleet CO_2 Reduction, %	50.2	49.2	47.9	46.3
New Capacity Req'd, GW	25.5	57.5	98.5	153.3
Additional Coal Req'd., tons x 10^3	79,940	179,864	308,338	479,637
Cost of New Capacity, MM$	45,975	103,444	177,332	275,850
Cost of CO_2 Retrofits, MM$	91,950	91,950	91,950	91,950
Total New Cost, MM$	137,925	195,394	269,282	367,800

Need for further R&DD to minimize the cost and externalities impact due to CO_2 Capture and Storage.

Current Energy Penalty of CO_2 BACT MEA Absorption System

OxyCombustion and Other CO_2 Capture Technologies Solicitation (DE-PS26-05NT42464)

- **Solicitation Released in FY05**
- **2 New Oxycombustion Projects Selected**
  - B&W
    - Project Team: Air Liquide, Battelle
  - BOC Group
    - Project Team: Western Research Institute, Alstom
- **Total Value of awards $9.6 MM**
- **Awarded FY06**



FY06 – New Oxyfuel Combustion Projects

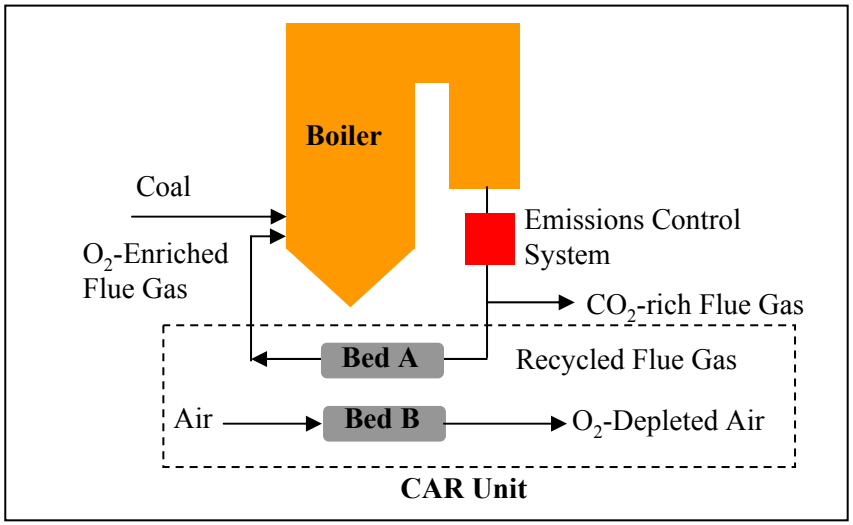
- **Babcock and Wilcox (B&W)**
  - Conduct five-million Btu per hour pilot-scale tests across a range of coal types including: Eastern bituminous coal, Power River Basin pulverized coal, sub-bituminous coal, and lignite coal.
  - Optimize the oxycombustion process by performing parametric testing in wall-fired and cyclone boiler configurations.
    - B&W's project expects to demonstrate that those cyclone boilers retrofitted with oxycombustion technology will demonstrate a cost-effective approach for CO2 capture coupled with much lower nitrogen oxide emissions.
  - Total value of this two-year project is $3.5 million.

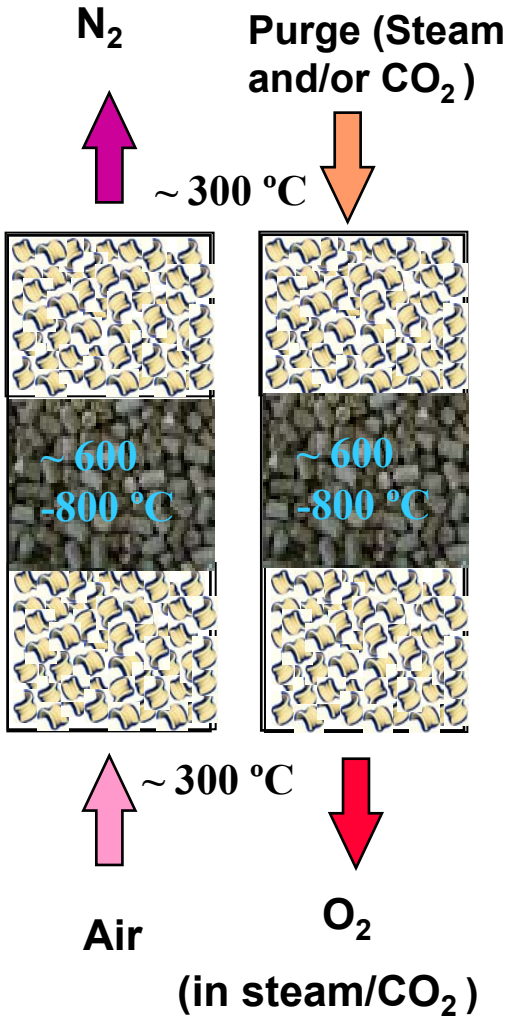
- **BOC Group, Inc.**
  - Combining oxycombustion technology with flue gas recycle in a process that replaces combustion air with a mixture of oxygen and recycled flue gas to produce a carbon dioxide-rich flue gas for sequestration.
  - Utilizing its CAR (Ceramic Autothermal Recovery) oxygen production process to reduce the cost of oxygen.
    - CAR uses the mineral Perovskite to absorb oxygen and subsequently release it in a circulating fluidized bed and pulverized coal pilot-scale firing configuration.
  - Total value of this three-year project is $6.1 million.

CAR Technology

BOC 42748

- **High temperature (T > 550 ºC), Cyclic steady state process; uses perovskites pellets in a fixed-bed**
- **Oxygen-enriched product stream at high temperature: ~ 300 ºC; low purity O_2 (high N_2 rejection); high O_2 recovery**
- **Oxy-fuel combustion for power production**
  - Main Driver: CO_2 sequestration
  - Target ~25% savings compared to O_2 from cryogenic ASU

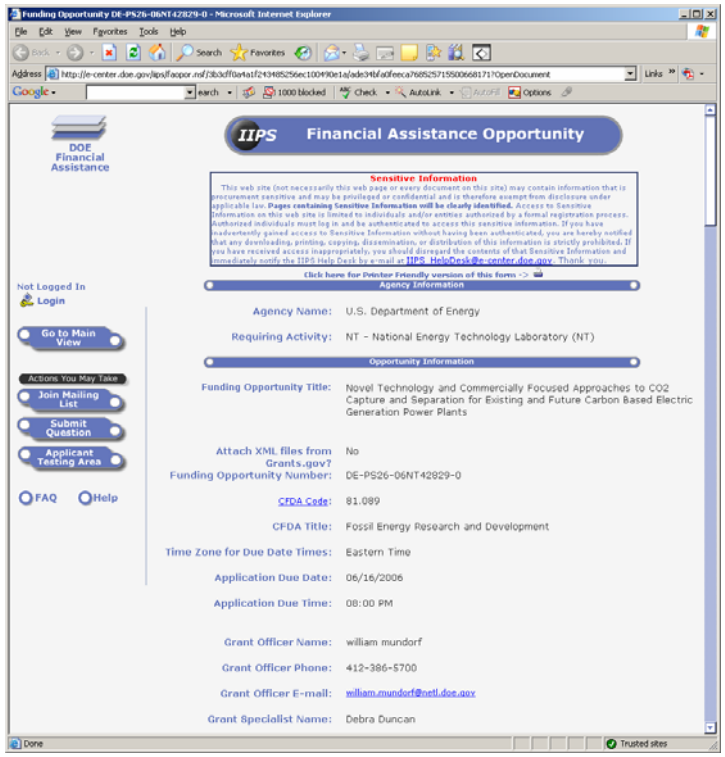




Future Opportunities

Funding Opportunity Announcement
DE-PS26-06NT42829

'Novel Technology and Commercially Focused Approaches to CO_2 Capture and Separation for Existing and Future Carbon Based Electric Generation Power Plants'



Released: April 19, 2006

Closing Date: June 16, 2006

Area of Interest 1 - Breakthrough Approaches to Carbon Dioxide and Separation

Area of Interest 2 - Continued Development of Direct CO_2 Capture and Separation Technologies

Area of Interest 3 - Field-testing of CO_2 Capture and Separation Technologies

$39 Million DOE over 3-yrs

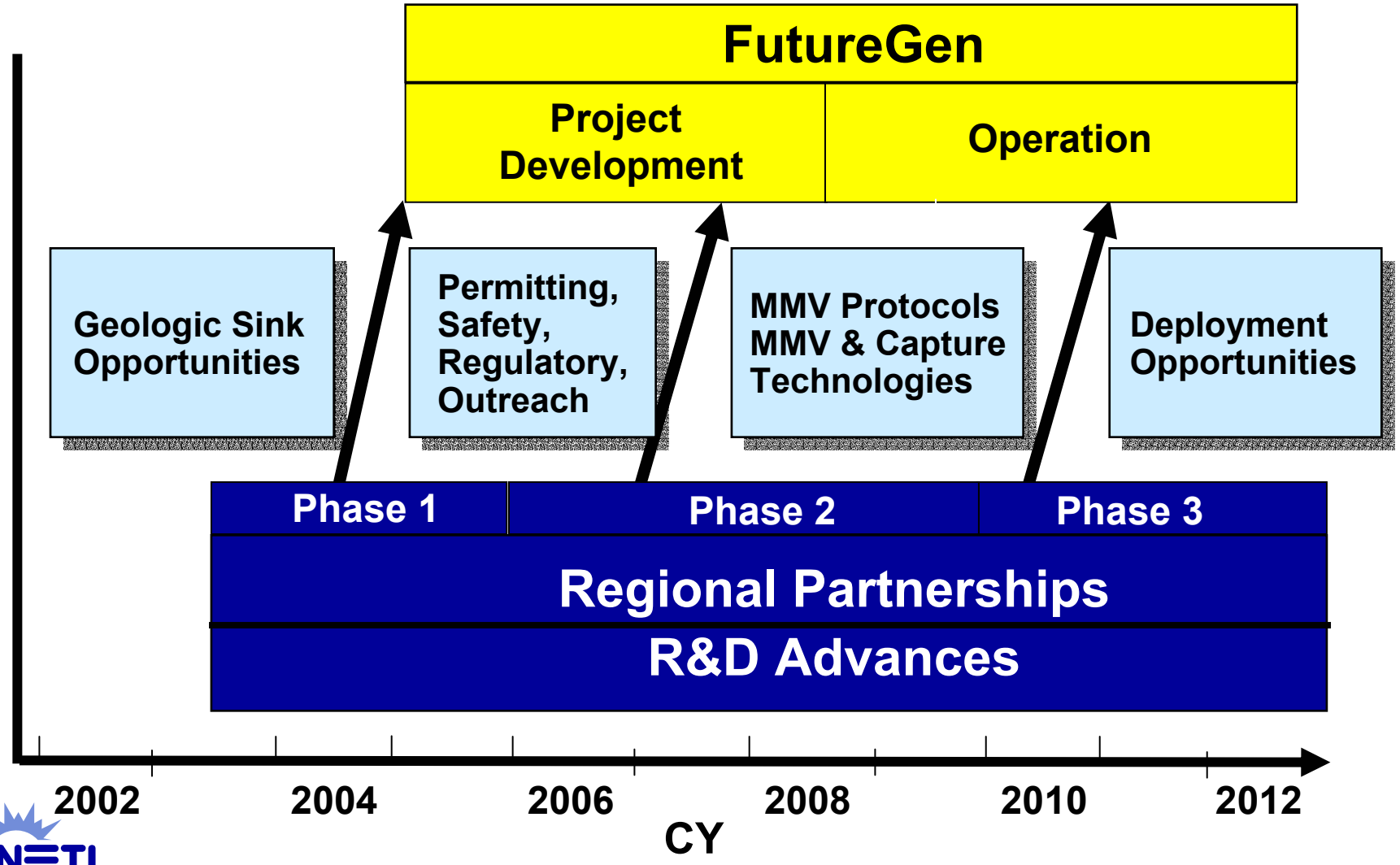
Cost-Sharing required of 20% of project costs

Website: http://www.netl.doe.gov/business/solicitations/index.html#42829

Potential National Lab Call

- Released in FY07
- Funding in FY08
- Focused Areas directed towards Program Goals
- Initial Stages of Planning – more info later

FutureGen Connection



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National Energy Technology Laboratory

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  - Coal & Power Systems
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    - Monitoring, Mitigation, Verification
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Technologies
Carbon Sequestration

NETL manages a portfolio of laboratory and field R&D focused on technologies with great potential for reducing greenhouse gas emissions and controlling global climate change. Most efforts focus on capturing carbon dioxide from large stationary sources such as power plants, and sequestering it using geologic, terrestrial ecosystem, or oceanic approaches. Control of fugitive methane emissions is also addressed.

Carbon sequestration work directly implements the President's Global Climate Change Initiative, as well as several National Energy Policy goals targeting the development of new technologies. It also supports the goals of the Framework Convention on Climate Change and other international collaborations to reduce greenhouse gas intensity and greenhouse gas emissions.

The programmatic timeline is to demonstrate a portfolio of safe, cost effective greenhouse gas capture, storage, and mitigation technologies at the commercial scale by 2012, leading to substantial deployment and market penetration beyond 2012. These greenhouse gas mitigation technologies will help slow greenhouse

NEWS & FEATURES // All >

- Carbon Sequestration Technology Roadmap [PDF-4542KB]
- Carbon Sequestration Program Outreach Plan [PDF-1438MB]
- DOE-Advances Commercialization of Climate Change Technology
- Regional Carbon Sequestration Partnerships Program Adds Canadian Provinces

EVENTS CALENDAR // All >

- The 2006 EIC Climate Change Technology Conference - Engineering Challenges and Solutions in the 21st Century

PUBLICATIONS & PROJECTS // All >

- Carbon Sequestration Reference Shelf
- Carbon Sequestration Project Portfolio [PDF-

http://www.netl.doe.gov/technologies/carbon_seq/index.html

THANK YOU FOR YOUR

PARTICIPATION IN MAKING

THIS A SUCCESSFUL CONFERENCE

SEE YOU NEXT YEAR!